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Hardcopy (HC) 3.00

Microfiche (MF) .65

FF 653 July 65

NASA SPECIAL PUBLICATIONS

Currently Available

N68-12136

(ACCESSION NUMBER)

(THRU)

49

(PAGES)

1

(CODE)

30

(CATEGORY)

FF No. 602(C)

(NASA CR OR TMX OR AD NUMBER)

FALL

1967

Introduction

The Special Publications described in this catalog reflect the manifold activities of the National Aeronautics and Space Administration. Many of them report scientific findings. These publications include recent photographs of the Earth, its Moon, and other planets; data obtained from instruments in interstellar space; histories of significant flights; and proceedings of conferences and symposia of specialists in many different academic disciplines.

Advances in engineering, technology, and management to meet men's needs in space also are reported in NASA Special Publications. Many of the recent discoveries and innovations of NASA Research Centers, contractors, and subcontractors already are aiding the professional personnel of other industries and of medical, educational, and research institutions. The Technology Utilization Series (pages 25 to 32) emphasizes information and data that can be useful to persons meeting challenges to mankind on Earth as well as in space. Such persons may also find the bibliographies and other reference works listed here (pages 35 to 38) helpful in their fields.

The initials GPO preceding the price of a publication indicate that it may be purchased from the *Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402*.

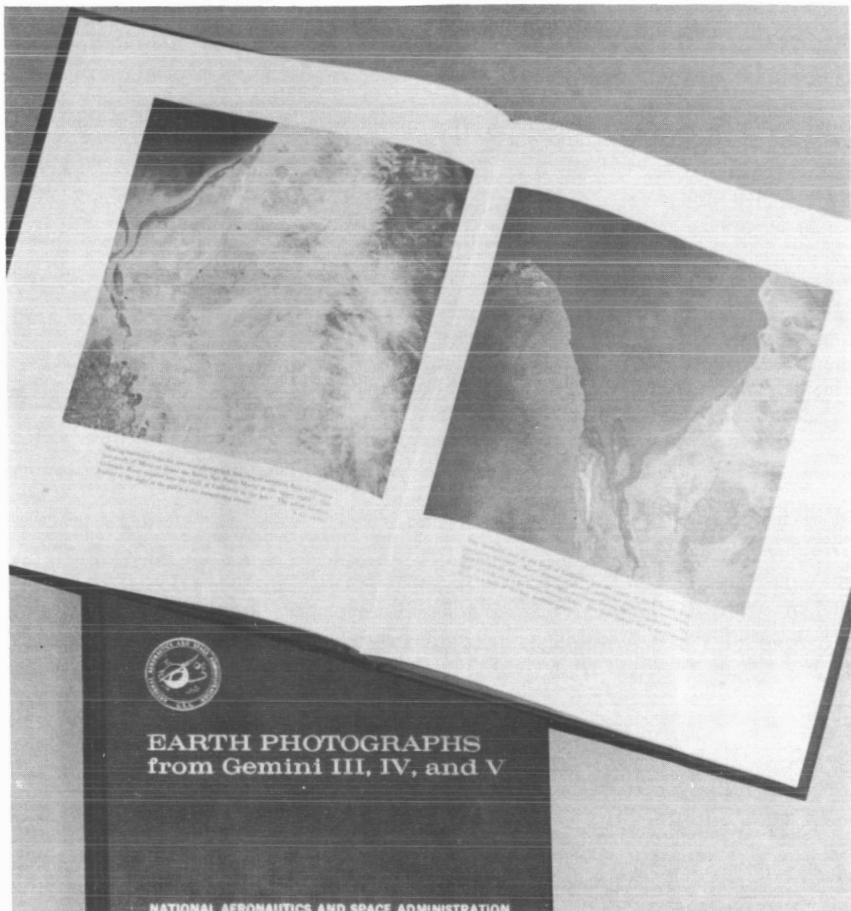
The initials CFSTI preceding the price of a publication indicate that it may be purchased from the *Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151*.

All of the publications described in this catalog were issued before June 30, 1967. To order one, please identify it both by its title and the "NASA SP" number assigned to it.

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General Series



Earth Photographs From Gemini III, IV, and V

Taken from altitudes of 100 or more miles, the color photographs of our Earth in this volume show aspects of it never seen before by artists nor recognized by scientists. Full-page reproductions of 244 pictures, taken by astronauts during 185 orbits of the Earth in 1965, show mountainous, barren, and cultivated areas in the United States, Mexico, Africa, the Arabian Peninsula, and elsewhere. Specialists in nearly every earth science are finding these and similar views of shorelines, islands, cloud formations, smoke streams, rainfall patterns, and sand dunes highly informative. Meteorologists are using them to interpret pictures from other sources. Geologists, oceanographers, foresters, and even urbanologists foresee practical uses for such synoptic views of the planet.

Captions identify the location and many significant details in this selection of the most interesting of 550 pictures taken on three historic flights. An appendix lists all of the photographs in orbital sequence. NASA SP-129 1967 276 pp. GPO \$7.00

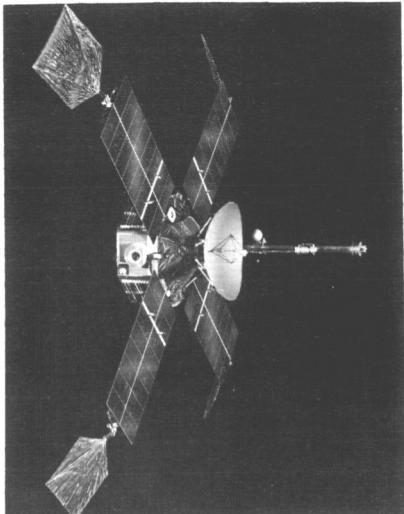
NASA SP-129 1967 276 pp. GPO \$7.00

A Review of the Mariner IV Results

By *Oran W. Nicks*

Mariner IV revealed the thinness of the atmosphere, moon-like craters, and other features of Mars to men. In this paper the director of Lunar and Planetary Programs of the NASA Office of Space Science and Applications describes this historic space-craft, its trajectory, and the experiments that it carried on its journey to within 9,487 kilometers of Mars. Engineering advances, technological lessons learned, and findings regarding the interplanetary environment are summarized. A discussion of scientific highlights is illustrated with computer-enhanced pictures of portions of the Martian surface covered by the television system.

NASA SP-130 1967
39 pp. 25 cents



Spacecraft Sterilization Technology

This volume contains 36 papers prepared for a conference at the Jet Propulsion Laboratory in November, 1965. Four of them explain NASA's efforts to facilitate the search for extraterrestrial life by preventing contamination of the findings. Others describe microbial contamination control and monitoring, and sterilization techniques applicable to spacecraft components, payloads, and facilities. This JPL conference, coordinated by the American Institute of Biological Sciences, brought more than 700 scientists, engineers, and administrators together.

NASA SP-108 1967 630 pp. GPO \$2.25

Aerospace Measurement Techniques

Gene G. Manella, Ed.

Possible bases for new instrumentation concepts were considered at a Massachusetts Institute of Technology symposium in July, 1966, sponsored by the NASA Electronics Research Center. This volume contains 14 papers presented there on such topics as holography, laser radars, and spectroscopy at microwave frequencies. Many are tutorial.

NASA SP-132 1967 261 pp. GPO \$1.00

Astronomy in Space

Three papers presented at the 121st meeting of the American Astronomical Society in March, 1966, by Homer E. Newell, Henry J. Smith, and Nancy G. Roman on, respectively, the NASA space astronomy program, solar astronomy, and stellar and galactic astronomy—plus an account of expanding vistas in astronomy by George E. Mueller noting opportunities opened by manned flight capability.

NASA SP-127 1967 67 pp. GPO 45 cents

A Survey of Space Applications

Real and feasible uses of space technology in communications, surveying the Earth's resources, geodesy, meteorology, and navigation are discussed. Prepared for a National Academy of Sciences summer study, with a foreword by James E. Webb.

NASA SP-142 1967 135 pp. GPO 70 cents

BENCHMARKS IN SPACE SCIENCE

Significant Achievements in Space Science 1965

Twenty-one Mariner IV pictures of Mars revised men's knowledge of that planet in 1965. This and other accomplishments are reviewed in papers on space astronomy, ionospheres and radio physics, planetary atmospheres, planetology, and solar physics.

NASA SP-136 1967 218 pp. GPO \$1.00

Significant Achievements in Space Applications 1965

This companion volume to NASA SP-136 (described above) summarizes noteworthy accomplishments in communications, geodesy, and meteorology.

NASA SP-137 1967 85 pp. GPO 45 cents

Advances in 10 scientific disciplines during the 1958 to 1964 period have been summarized in separate volumes for the convenience of readers.

Significant Achievements in Space Astronomy 1958-1964

X-ray, gamma-ray, ultraviolet, infrared, and low-frequency radio astronomy are emphasized. NASA SP-91 1966 73 pp.

GPO 45 cents

Significant Achievements in Space Bioscience 1958-1964

The origins of NASA's biological program and its practical implications are explained. NASA SP-92 1966 128 pp.

GPO 55 cents

Significant Achievements in Space Communications and Navigation 1958-1964

Describes passive and active communication satellites and technology developed for the early systems.

NASA SP-93 1966 68 pp.
GPO 45 cents

Significant Achievements in Satellite Geodesy 1958-1964

How satellites aided study of Earth's gravity field, surface distances, and astronomical constants.

NASA SP-94 1966 174 pp.
GPO 60 cents

Significant Achievements in Ionospheres and Radio Physics 1958-1964

Plasma properties of the ionosphere are reviewed with emphasis on the topside of the F-region.

NASA SP-95 1966 60 pp.
GPO 45 cents

Significant Achievements in Satellite Meteorology 1958-1964

Findings with satellites and sounding rockets are documented, and further achievements foreseen.

NASA SP-96 1966 141 pp.
GPO 60 cents

Significant Achievements in Particles and Fields 1958-1964

A survey of theoretical investigations and space observations of particles and magnetic fields.

NASA SP-97 1966 94 pp.
GPO 50 cents

Significant Achievements in Planetary Atmospheres 1958-1964

Highlights and results of studies of Earth, meteoroids, Mars, Venus, and Jupiter are reviewed.

NASA SP-98 1966 59 pp.
GPO 45 cents

Significant Achievements in Planetology 1958-1964

Advances in knowledge of Venus, Mars, and the lunar surface with new instruments are described.

NASA SP-99 1966 71 pp.
GPO 45 cents

Significant Achievements in Solar Physics 1958-1964

Frontiers of solar research, mapping and monitoring of solar radiation, are the theme of this survey.

NASA SP-100 1966 96 pp.
GPO 50 cents

Second Symposium on the Role of the Vestibular Organs in Space Exploration

Twenty-three papers presented at an Ames Research Center symposium in January, 1966, under the auspices of the National Academy of Sciences—National Research Council Committee on Hearing, Bioacoustics, and Biomechanics. Practical problems posed by weightlessness and subgravity, and findings in current work with both animal and human subjects are among the topics discussed. NASA SP-115 1967 312 pp. GPO \$2.00

Papers presented at a similar conference at Pensacola, Fla., in January, 1965, have also been published under the title "The Role of the Vestibular Organs in the Exploration of Space" and are available in:

NASA SP-77 1965 392 pp. GPO \$2.50

The Dynamic Behavior of Liquids in Moving Containers

Applications to space technology are stressed in this Southwest Research Institute review of problems posed by the sloshing and other motions of liquids and the effects on a vehicle's stability and control. Simulation and experimental techniques are described, and liquid propellant behavior at low and zero gravity is discussed. An appendix lists physical properties of selected liquids.

NASA SP-106 1967 467 pp. GPO \$2.70

First Compilation of Papers on Trajectory Analysis and Guidance Theory

Seven technical papers prepared by contractors for the NASA Electronics Research Center Guidance Laboratory on celestial mechanics, impulse transfers, functional models, and calculus of variation. They describe work intended to be useful in trajectory analysis and guidance theory, space mission design, and orbit determination or prediction.

NASA SP-141 1967 215 pp. CFSTI \$3.00

Second Annual NASA-University Conference on Manual Control

Twenty-nine papers presented at a 1966 Massachusetts Institute of Technology interdisciplinary conference on "man in the loop" of complex control systems. Session topics included discrete and continuous models, adaptive control, information theory, multi-variable control, display, motion and stress, optimal control, and analysis and design methods.

NASA SP-128 1967 417 pp. GPO \$2.50

Involuntary Hypohydration in Man and Animals: A Review By John E. Greenleaf

This review summarizes the literature pertaining to delay in rehydration following water loss and associated factors influencing water intake by man and animals.

NASA SP-110 1966 34 pp. GPO 30 cents

Fifth National Conference on the Peaceful Uses of Space

Proceedings of a 1965 meeting in St. Louis of representatives of industry, the scientific community, and government to review accomplishments, goals, future programs, and the impact of space exploration on industry, communication, education, philosophy, and society. This volume includes "Looking Toward Maturity in the Space Age," by Dr. Hugh L. Dryden, NASA Deputy Administrator, who died in December, 1965.

NASA SP-82 1966 200 pp. GPO \$1.50

The first National Conference on Peaceful Uses of Space was held in Tulsa in 1961, the second at Seattle in 1962, the third in Chicago in 1963, and the fourth at Boston in 1964. Proceedings of these conferences have also been published by NASA:

No number 1961 184 pp. GPO \$1.25

NASA SP-8 1962 282 pp. GPO \$1.50

NASA SP-40 1963 301 pp. GPO \$2.00

NASA SP-51 1964 226 pp. GPO \$1.50

SPACE TECHNOLOGY TEXTS

NASA Special Publications include a series of short basic texts for upper-level college engineering students. These were based on notes prepared for summer courses, the first five of which were given by the California Institute of Technology and the sixth at the University of California at Los Angeles. The staff of the Jet Propulsion Laboratory and many academic and industrial authorities helped plan these courses and publications.

Space Technology Vol. I: Spacecraft Systems By L. H. Abraham

Methods of planning spacecraft and relating and utilizing various subsystems are described. The author shows how to establish relationships of various parts and the utilization of various subsystems before designs are committed.

NASA SP-65 1965 85 pp.
GPO 35 cents

Space Technology Vol. II: Spacecraft Mechanical Engineering By James L. Adams

Structural, temperature-control, and electronic-packaging methods and basic theory are included.

NASA SP-66 1965 166 pp.
GPO 60 cents

Space Technology Vol. III: Spacecraft Propulsion By F. E. Marble

To be published as NASA SP-67.

Space Technology Vol. IV: Spacecraft Guidance and Control By J. R. Scull

Tradeoffs among injection, midcourse, and terminal guidance, and ways of mechanizing systems, are covered.

NASA SP-68 1967 143 pp.
GPO 55 cents

Space Technology Vol. V: Telecommunications By J. J. Stiffler

Fundamentals, modulation, data compression, and systems in use and planned are described.

NASA SP-69 1967 142 pp.
GPO 55 cents

Space Technology Vol. VI: Space Sciences By T. A. Farley

A discussion of the geomagnetic field, Van Allen belt, galactic and solar cosmic rays, comets, and dust.

NASA SP-114 1967 84 pp.
GPO 35 cents

Orbiting Solar Observatory Satellite OSO I: The Project Summary

A description of the work performed in connection with the Orbiting Solar Observatory, launched March 7, 1962, including details on spacecraft dynamics, structural design and fabrication, control systems, data acquisition and command systems, power supply, thermal control, testing, and experiments carried out with the OSO I.

NASA SP-57 1966 306 pp. GPO \$2.00

Medical Aspects of an Orbiting Research Laboratory

A report by the Space Medicine Advisory Group (SPAMAG), a group of consultants representing varied disciplines in the life sciences. Recommendations fall in three broad categories: (1) life support; (2) experiments to test the response in the space environment; and (3) research laboratory design and operation.

NASA SP-86 1966 144 pp. GPO \$1.00

Bioenergetics of Space Suits for Lunar Exploration

A Literature Review by Emanuel M. Roth

This report discusses the new problems in optimal space-suit system design presented by the potential for severe physical exertion outside the spacecraft and on the surface of the Moon and other celestial bodies. Subjects covered include the metabolic load imposed on humans by exertion, the mechanics of locomotion under varied terrain and gravity conditions, mobility restriction in space suits, and problems of thermal control

NASA SP-84 1966 140 pp. GPO \$1.00

Human Response to Sustained Acceleration

A Literature Review by T. M. Fraser

A critical review of the open literature in the field, this report deals with the natural history and physiological effects of sustained acceleration and with human tolerance and performance during acceleration stress.

NASA SP-103 1966 136 pp. GPO \$1.00

Vacuum Technology and Space Simulation

*By Donald J. Santeler, David H. Holkeboer,
Donald W. Jones, and Frank Pagano*

A single source handbook which consolidates the numerous interacting vacuum techniques required for space simulation and which is specifically designed for the engineer who needs to purchase, operate, maintain, or otherwise use vacuum space simulation equipment and who must have a thorough understanding of the principles of vacuum technology.

NASA SP-105 1966 306 pp. GPO \$1.00

Development of a Small Animal Payload and Integration with a Sounding Rocket

Larry J. Early, Ed.

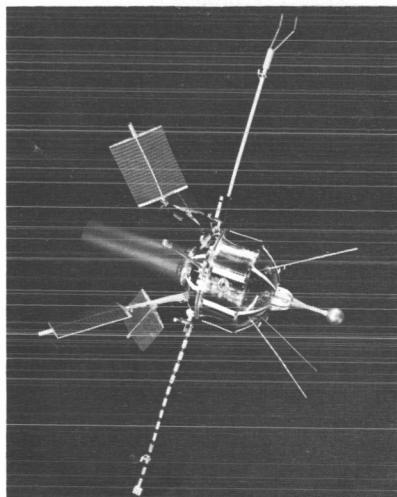
A report on the results of Phase I of the Bio-Space Technology Program, describing the design, development, and integration with a modified Arcas launch vehicle of a small-animal payload. Included are discussions of trajectory and performance, vehicle aerodynamic analysis, payload and recovery systems design, biological bench tests, payload flight-qualification testing, and flight tests and results.

NASA SP-109 1966 98 pp. GPO 60 cents

Ariel I: The First International Satellite

In Ariel I, a pilot project to establish a pattern of international cooperation, scientists and engineers of the United Kingdom and the United States studied the ionosphere and its relation to the sun. This account covers the project's organization, the satellite's useful life (from April 1962 to November 1964), and the results. It describes the satellite's structure and major subsystems, and the tracking, data acquisition and data reduction operations. This is a summary document, prepared by Goddard Space Flight Center, in which readers will find guidance to further details of particular facets of a project which Sir Harry Massey, Chairman of the British National Committee for Space Research, has acclaimed as "generally successful both technologically and scientifically."

NASA SP-119 1967 158 pp.
GPO \$1.50



Under the same title a project summary was published as NASA SP-43 (1963 76 pp. GPO 70 cents).

Gemini Midprogram Conference

This report contains 46 papers presented at the Gemini Midprogram Conference held at the Manned Spacecraft Center, Houston, Texas, February 23-25, 1966. The first group of 30 papers describes the spacecraft and launch vehicle, flight operations, and mission results, and includes accounts of the Gemini VI-A and VII rendezvous and the astronauts' reactions to the flight; the second group reports on in-flight experiments.

NASA SP-121 1966 444 pp. GPO \$2.75

Philosophy of Simulation in a Man-Machine Space Mission System

An examination of the philosophy of simulation as it pertains to manned space activities, with particular orientation to research in the life sciences.

NASA SP-102 1966 107 pp. GPO 50 cents

Proceedings of a Conference on Theoretical Biology

A series of discussions on de novo cell synthesis and population ecology held at Princeton, N.J., November 22-24, 1963, under the sponsorship of NASA and the American Institute of Biological Sciences.

NASA SP-104 1966 188 pp. GPO \$1.00

Proceedings of a Symposium on Passive Gravity-Gradient Stabilization

Proceedings of a symposium held at Ames Research Center, May 10-11, 1965, to document the current state of the art in hardware development for gravity-gradient control systems.

NASA SP-107 1966 269 pp. GPO \$1.75

Dynamic Stability of Rotor-Bearing Systems

By Edgar J. Gunter, Jr.

The report of an investigation of the conditions in a rotor system which can lead to a type of a self-excited, unstable motion variously known as shaft whirling, oil film whirl, resonance whip, or half-frequency whirl, but referred to here as nonsynchronous precession. Theoretical results and experimental observations are compared.

NASA SP-113 1966 228 pp. GPO \$1.00

Conference on V/STOL and STOL Aircraft

Papers presented at a conference held at Ames Research Center, Moffett Field, Calif., April 4-5, 1966, summarizing recent NASA research results related to the aerodynamic, propulsion, and handling-quality aspects of V/STOL and STOL aircraft. Included are three NASA-supported feasibility studies of concepts for short-haul transports prepared by Boeing, Ling-Temco-Vought, and Lockheed.

NASA SP-116 1966 467 pp. CFSTI \$3.00

Space Power Systems Advanced Technology Conference

Proceedings of a conference held at Lewis Research Center, August 23-24, 1966, to review progress in space power systems technology. The information presented includes contributions by NASA contractors and by the Department of Defense and the Atomic Energy Commission and their contractors.

NASA SP-131 1966 285 pp. CFSTI \$3.00

Summary Report on the NASA-Western University Conference

A summary of NASA's first regional University Conference, November 8-9, 1965, at the Jet Propulsion Laboratories in Pasadena, Calif., with university participants drawn from the 13 Western States. At this meeting, NASA personnel discussed the agency's accomplishments, ongoing programs, and plans for the promotion of mutually beneficial relationships between the Nation's space program and the academic community.

NASA SP-122 1966 58 pp. CFSTI \$3.00

Progress in Development of Methods in Bone Densitometry

Proceedings of a conference held in Washington, D.C., March 25-27, 1965, under the joint sponsorship of NASA, the National Institute of Arthritis and Metabolic Diseases (NIH), and the American Institute of Biological Sciences. The report covers various methods of studying and measuring bone demineralization.

NASA SP-64 1966 204 pp. GPO \$1.50

Space Cabin Atmospheres

Part I: Oxygen Toxicity

Part II: Fire and Blast Hazards

Part III: Physiological Factors of Inert Gases

These three volumes are open literature reviews by Emanuel M. Roth, relating oxygen to other factors of concern in space cabins, discussing environmental hazards, and noting physiological effects of chemically inert gases.

NASA SP-47 Part I 1964 51 pp. GPO 40 cents

NASA SP-48 Part II 1964 119 pp. GPO \$1.00

NASA SP-117 Part III 1967 136 pp. GPO \$1.00

Scientific Findings From Explorer VI

Selected papers and reports on data collected by Explorer VI, designed to provide a coordinated, comprehensive group of measurements of scientific interest over as large a region of the magnetosphere as possible. NASA SP-54 1965 381 pp. GPO \$2.25

Surveyor I, A Preliminary Report

A summary of both engineering and scientific aspects of the highly successful Surveyor I spaceflight—the first American soft landing on the Moon. Illustrated with photographs relayed by the spacecraft. The vehicle, its trajectory, and tracking and data acquisition are described.

NASA SP-126 1966 40 pp. CFSTI \$3.00

Observations From the Nimbus I Meteorological Satellite

Six papers presented by personnel of Goddard Space Flight Center at the Western Annual Meeting of the American Geophysical Union, held December 29, 1964, in Seattle, Wash. Early results obtained with the Nimbus I satellite are discussed.

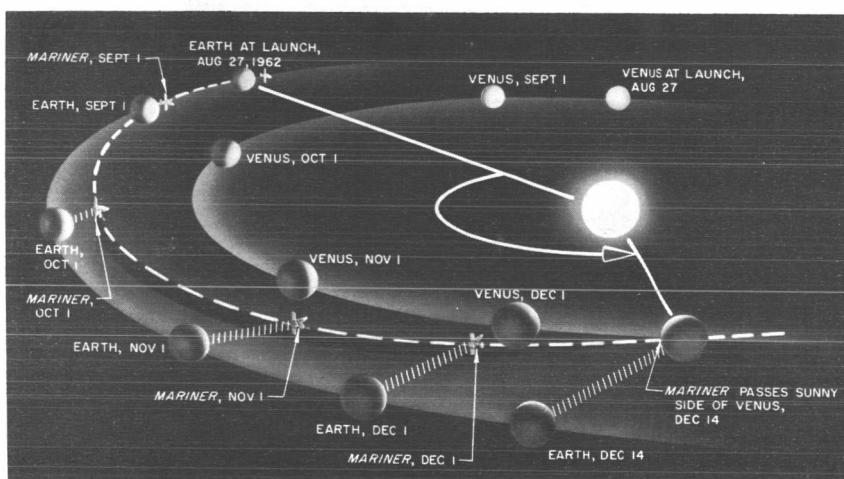
NASA SP-89 1965 90 pp. CFSTI \$3.00

Proceedings of the Apollo United S-Band Technical Conference

Papers presented at the conference held July 14–15, 1965, at Goddard Space Flight Center. The presentations, made by persons directly involved in the Apollo program, describe in some detail the ground systems required.

NASA SP-87 1965 302 pp. CFSTI \$3.00

Mariner-Venus 1962: Final Project Report



Prepared by the Jet Propulsion Laboratory, this report describes the flight of the Mariner II spacecraft to the vicinity of Venus. The chronology begins with the activation of the project to meet the 1962 Venus launch opportunity. Chapters include project organization and management; spacecraft system design and development; operational events; evaluation of the subsystems, the tracking network, the data-recovery and processing system; and scientific findings.

NASA SP-59 1965 344 pp. GPO \$2.50

An Analysis of the Extraterrestrial Life Detection Problem

By Richard S. Young, Robert B. Painter, and Richard D. Johnson

Guidelines and ground rules for a cohesive study of the solar system and beyond for evidences of life—past, present, or future. The study includes a section on “The Attributes of Life” and is mainly concerned with a discussion of conditions on Mars.

NASA SP-75 1965 33 pp. CFSTI \$3.00

NASA 1965 Summer Conference on Lunar Exploration and Science

Results of the conference on lunar exploration, held in Falmouth, Mass., July 19–31, 1965, including the conclusions and recommendations drawn from it. An overall lunar-mission summary is given, together with the working-group reports from which the summary was obtained, in the disciplines geodesy/cartography, geology, geophysics, bioscience, geochemistry (mineralogy and petrology), particles and fields, lunar atmosphere measurements, and astronomy.

NASA SP-88 1965 422 pp. GPO \$1.50

The Meteoroid Environment and Its Effects on Materials and Equipment

By William A. Cosby and Robert G. Lyle

A detailed study, prepared by the National Academy of Sciences, of publications appearing since 1960 on the meteoroid environment and its effects on materials and equipment. Divided into the following sections: Environment, Hypervelocity Impact Phenomena, and Design Considerations.

NASA SP-78 1965 116 pp. GPO 50 cents

Second Symposium on Protection Against Radiations in Space

Papers of a conference at Gatlinburg, Tenn., October 12–14, 1964, and sponsored by AEC, NASA, and USAF. Four disciplines are represented: The Radiation Environment, Biological Effects, Effects on Materials, and Shielding.

NASA SP-71 1965 551 pp. GPO \$3.25

Final Report on the Relay I Program

This report deals with (1) the design, development, and performance of the spacecraft hardware; (2) the various experiments performed (communications and radiation) at the Nutley, N.J., and the Andover, Maine, ground stations; and (3) information received from foreign participants in the Relay I project.

NASA SP-76 1965 767 pp. GPO \$1.75

Symposium on Thermal Radiation of Solids

S. Katzoff, Ed.

Symposium held in San Francisco, Calif., March 4–6, 1964, sponsored by NASA, the National Bureau of Standards, and the USAF's Aeronautical Systems Division. The document also carries Air Force No. ML-TDR-64-159. Author and subject indexes.

NASA SP-55 1965 620 pp. GPO \$3.75

Conference on Aircraft Operating Problems

Papers presented at a conference at Langley Research Center, May 10–12, 1965. Contributions were made by Ames Research Center, Flight Research Center, and Langley Research Center, as well as by representatives of the Federal Aviation Agency.

NASA SP-83 1965 327 pp. CFSTI \$3.00

Ranger IX Photographs of the Moon: Cameras "A," "B," and "P"

This is the fifth in a series of volumes of photographs of the Moon taken by the Rangers. It shows 170 selected Ranger IX frames. NASA SP-112 1966 187 pp. GPO \$6.50

The other volumes in this series are: Ranger VIII Photographs of the Moon: Cameras "A," "B," and "P" NASA SP-111 (1966 187 pp. GPO \$6.50); Ranger VII Photographs of the Moon, Part I, Camera "A" Series, NASA SP-61 (1964 226 pp. GPO \$6.50); Part II, Camera "B" Series, NASA SP-62 (1965 217 pp. GPO \$6.50); and Part III, Camera "P" Series, NASA SP-63 (1965 200 pp. GPO \$6.50).

Mercury Project Summary Report, Including Results of the Fourth U.S. Manned Orbital Flight, May 15-16, 1963

A review of the planning, preparation, and results of Astronaut L. Gordon Cooper's 34-hour mission. NASA SP-45 1963 444 pp. GPO \$2.75

Results of the first, second, and third U.S. Manned Orbital Flights in 1962 are summarized in:

1st Flight No number 1962 204 pp. GPO \$1.25
2d Flight NASA SP-6 1962 107 pp. GPO 65 cents
3d Flight NASA SP-12 1962 120 pp. GPO 70 cents

Results of U.S. Manned Suborbital Flights in 1961 are summarized in:

1st Flight No Number 1961 58 pp. GPO 45 cents
2d Flight No number 1961 76 pp. GPO 50 cents

Proceedings of 2d NASA-Industry Program Plans Conference

Speeches and statements describing NASA's organization, present plans, and possible future projects, presented at a conference in Washington, D.C., February 11-12, 1963, for the information of industrial management as a partner in the national space program. NASA SP-29 1963 231 pp. GPO \$1.25

A similar conference in 1960 in Washington, D.C., is reported in "NASA Industry Program Plans Conference" (No Number 1960 124 pp. GPO 75 cents).

Proceedings of the Conference on Law of Space and of Satellite Communications

Proceedings of a conference organized by Northwestern University School of Law, Evanston, Ill., May 1-2, 1963, as part of the Third National Conference on the Peaceful Uses of Space. The formal papers and comments in the first part of the volume represent an attempt to provide a broad perspective of the legal problems that have arisen and will emerge in the space age, and to indicate to what degree informal legal thought has reached a consensus or formulated tentative conclusions as to their resolution. The second part of the volume is concerned with monopoly, antitrust, administrative, and international aspects of communications satellite operations. NASA SP-44 1964 205 pp. GPO \$1.50

Concepts for Detection of Extraterrestrial Life *Freeman H. Quimby, Ed.*

The devices and instruments described in this illustrated booklet are among those planned for inclusion in vehicles designed to land on planets such as Mars. They constitute techniques for detecting growth and metabolism, for determining the presence of biologically significant molecules, and for actual visual observation of microorganisms and the planetary terrain. NASA SP-56 1964 53 pp. GPO 50 cents

Dictionary of Technical Terms for Aerospace Use

William H. Allen, Ed.

This first edition of a dictionary for space scientists and technologists contains more than 6000 carefully chosen and precisely defined terms. It does not attempt, however, to include every aspect of space terminology.

NASA SP-7 1965 314 pp. GPO \$3.00

Short Glossary of Space Terms

Brief definitions of frequently used space terms, selected from the *Dictionary of Technical Terms for Aerospace Use* (NASA SP-7). Second edition.

NASA SP-1 1966 52 pp. GPO 25 cents

Survey of the Literature on the Solar Constant and the Special Distribution of Solar Radiant Flux

By M. P. Thekaekara

Survey of currently available data on this subject, including a discussion of relevant theoretical considerations concerning radiation, solar physics, scales of radiometry, and the thermal balance of spacecraft.

NASA SP-74 1965 43 pp. CFSTI \$3.00

Aerodynamic Design of Axial-Flow Compressors

Irving A. Johnson and Robert O. Bullock, Eds.

Results of extensive research on the design of axial-flow compressors have been assimilated and correlated in this volume. Attention has been focused primarily on the problems pertinent to turbojet or turboprop engines, but the results should be applicable to any class of axial-flow compressors.

NASA SP-36 1965 508 pp. GPO \$3.00

Symposium on the Analysis of Central Nervous System and Cardiovascular Data Using Computer Methods

Lorne D. Proctor and W. Ross Adey, Eds.

Proceedings of a conference held in Washington, D.C., October 29-30, 1964, at which Government and university authorities discussed use of computer techniques in collecting and analyzing data on the central nervous and cardiovascular systems.

NASA SP-72 1965 600 pp. CFSTI \$3.00

Physics of Nonthermal Radio Sources

Proceedings of a conference for an international group of astronomers and physicists, held December 3-4, 1962, at the NASA Goddard Institute for Space Studies, New York, N.Y. The papers cover radio observations, optical observations, and theory of nonthermal radio sources outside the solar system. Index.

NASA SP-46 1964 171 pp. GPO 75 cents

Meteorological Observations Above 30 Kilometers

Three papers on meteorological rockets, network data, and rocket soundings, comprising one session of a conference on Meteorological Support for Aerospace Testing and Operation, held at Colorado State University, Fort Collins, July 11-12, 1963.

NASA SP-49 1964 57 pp. GPO 40 cents

Advanced Bearing Technology
By Edmond E. Bisson and William J. Anderson

Exposition of the fundamentals of friction and wear, fluid-film bearings, and rolling element bearings, with demonstrations of how fundamental principles can be applied to the solution of unique and advanced bearing problems.

NASA SP-38 1964 511 pp. GPO \$1.75

Effect of Ionizing Radiation on a Series of Saturated Polyesters
By G. F. D'Aleio, Roland Haberli, and George F. Pezdirtz

The polyesters of dihydric alcohols, HO-R₁-OH, and dicarboxylic acids, HOOC-R₂-COOH, were prepared autocatalytically and underwent ionizing radiation. The observed radiation effects were correlated to the molecular weights of the respective polymers. It was shown that the structural features of the polyester segment derived from the polyesterification of specific diols and specific diacids influenced greatly the direction and magnitude of the radiation effects.

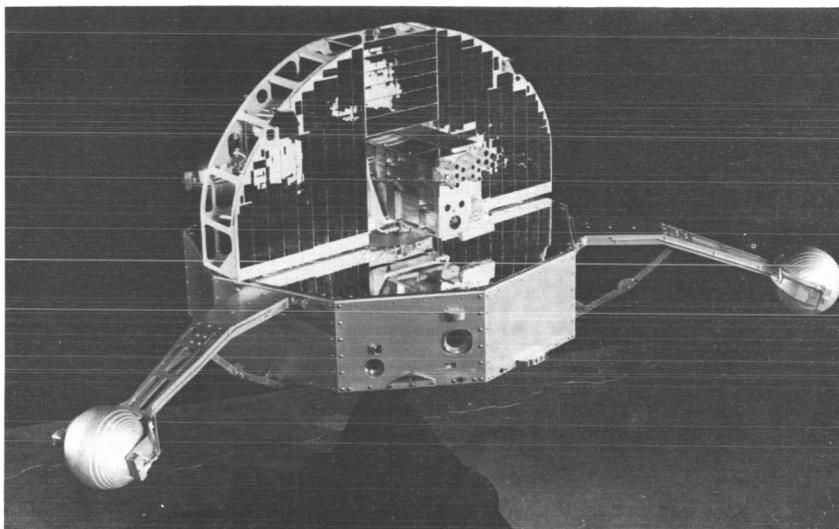
NASA SP-58 1964 63 pp. CFSTI \$3.00

Proceedings of the NASA-AEC Liquid-Metals Corrosion Meetings, Vol. I

Proceedings of the unclassified portions of a meeting, held at NASA's Lewis Research Center, October 2-3, 1963, on mechanisms of liquid-metal corrosion, the results of compatibility tests with alkali metals, and the problems related to compatibility testing with alkali metals.

NASA SP-41 1964 316 pp. CFSTI \$3.00

The Observatory Generation of Satellites



Discussion of the Orbiting Geophysical Observatories, the Advanced Orbiting Solar Observatory, and the Orbiting Astronomical Observatory at the Franklin Institute, Philadelphia, December 27, 1962.

NASA SP-30 1963 62 pp. GPO 50 cents

NASA University Program Review Conference

A review conducted at a conference in Kansas City, Mo., March 1-3, 1965, by university professors and administrators of the programs sponsored by NASA through grants and research contracts with universities throughout the country. Included are papers on X-ray and gamma-ray astronomy and biological research, as well as on the effect the grants and contracts have had on research.

NASA SP-85 1965 400 pp. GPO \$1.50

A "Summary Report on the NASA University Program Review Conference" described above is also available as NASA SP-81 (1965 37 pp. CFSTI \$3.00).

AAS-NASA Symposium on the Physics of Solar Flares *Wilmot N. Hess, Ed.*

Proceedings of a conference at Goddard Space Flight Center, October 28-30, 1963, on research progress in the field of solar-flare activity. Papers cover both observations and theory.

NASA SP-50 1964 465 pp. GPO \$3.25

A Quasi-Global Presentation of Tiros III Radiation Data *By Lewis J. Allison, Thomas I. Gray, Jr., and Guenter Warnecke*

Worldwide radiation map in the 8- to 12-micron atmospheric "window," as derived from Tiros III's Channel 2 measurements for July 16, 1961. The map, covering the globe between 55° N and 55° S, is superimposed on various conventional synoptic analyses to study the utility of satellite radiation data for meteorological-analysis purposes. Extra-large format.

NASA SP-53 1964 23 pp. GPO \$2.00

Conference on Nutrition in Space and Related Waste Problems

Proceedings of a conference at the University of South Florida in Tampa, April 27-30, 1964, on problems associated with maintaining astronauts in space. Approximately 60 papers with discussions by conferees.

NASA SP-70 1965 400 pp. GPO \$2.75

Electrical Power Generation Systems for Space Applications

State-of-the-art summary of several papers and committee reports on electric-power systems for space use, prepared by the Department of Defense and NASA for the supporting Research and Technical Panel of the Aeronautics and Astronautics Coordinating Board.

NASA SP-79 1965 40 pp. CFSTI \$3.00

Short-Term Frequency Stability

Proceedings of the IEEE-NASA Symposium on the Definition and Measurement of Short-term Frequency Stability held at the Goddard Space Flight Center, Greenbelt, Md., November 23-24, 1964. Four sessions: Users' Viewpoint and Requirements, Theory, Devices, and Measurement Techniques.

NASA SP-80 1965 317 pp. GPO \$1.75

X-15 Research Results, With a Selected Bibliography

By Wendell H. Stillwell

Semitechnical summary of the X-15 program, directed toward achievements in scientific research rather than the better publicized and spectacular milestones of flight in the near-space environment. Index.

NASA SP-60 1965 128 pp. GPO 55 cents

Proceedings of the NASA-University Conference on Science and Technology of Space Exploration, Vols. 1 and 2

State-of-the-art papers on NASA programs presented to the scientific and technical community at a conference held in Chicago, Ill., November 1-3, 1962.

NASA SP-11 1962 Vol. 1 429 pp. GPO \$2.50
Vol. 2 532 pp. GPO \$3.00

These papers have also been published individually as follows: "Geophysics and Astronomy in Space Exploration," NASA SP-13 (43 pp. GPO 35 cents); "Lunar and Planetary Sciences in Space Exploration," NASA SP-14 (85 pp. GPO 55 cents); "Celestial Mechanics and Space Flight Analysis," NASA SP-15 (41 pp. GPO 35 cents); "Data Acquisition From Spacecraft," NASA SP-16 (59 pp. GPO 40 cents); "Control Guidance, and Navigation of Spacecraft," NASA SP-17 (54 pp. GPO 40 cents); "Bioastronautics," NASA SP-18 (35 pp. GPO 30 cents); "Chemical Rocket Propulsion," NASA SP-19 (55 pp. GPO 40 cents); "Nuclear Rocket Propulsion," NASA SP-20 (62 pp. GPO 45 cents); "Power for Spacecraft," NASA SP-21 (26 pp. GPO 25 cents); "Electric Propulsion for Spacecraft," NASA SP-22 (37 pp. GPO 35 cents); "Aerodynamics of Space Vehicles," NASA SP-23 (56 pp. GPO 40 cents); "Gas Dynamics in Space Exploration," NASA SP-24 (51 pp. GPO 40 cents); "Plasma Physics and Magnetohydrodynamics in Space Exploration," NASA SP-25 (77 pp. GPO 50 cents); "Laboratory Techniques in Space Environment Research," NASA SP-26 (51 pp. GPO 40 cents); "Materials for Space Operations," NASA SP-27 (46 pp. GPO 35 cents); and "Structures for Space Operations," NASA SP-28 (46 pp. GPO 35 cents).

U.S. Standard Atmosphere, 1962

Tables of atmospheric parameters to 700 kilometers, incorporating results of rocket and satellite research through mid-1962 (No Number) 1962 278 pp. GPO \$3.50

Telstar I: Vols. 1, 2, and 3

Compilation of papers written by employees of Bell Telephone Laboratories who were involved in the Telstar project. Volume 3 contains an index to all three volumes.

NASA SP-32 1963 1940 pp. CFSTI \$3.00 per volume

Proceedings of the International Meteorological Satellite Workshop

Report of the workshop held in Washington, D.C., November 13-22, 1961, on the results of the meteorological-satellite program of the United States and the possibilities for the future. The workshop was sponsored by NASA and the Weather Bureau.

(No Number) 1962 226 pp. GPO \$1.75

NASA Day, April 27, 1962: Western Space Age Industries and Engineering Exposition and Conference

Published record of NASA participation in a conference in Washington, D.C., April 1962, at which speakers provided industrial management with information on NASA's programs and procedures.

NASA SP-4 1962 66 pp. GPO 45 cents

List of Selected References on NASA Programs

List of the selected NASA publications and releases issued during the 3 years following the agency's establishment in October 1958. NASA SP-3 1962 236 pp. GPO \$1.25

**Results of the Project Mercury Ballistic
and Orbital Chimpanzee Flights**

James P. Henry and John D. Moseley, Eds.

This publication presents a full account of the flights of the Project Mercury chimpanzees, from program-planning through launch and recovery operations. It gives a detailed account of training techniques, in-flight measurements, and post-flight evaluation procedures. These flights verified the feasibility of manned space flight.

NASA SP-39 1963 71 pp. GPO 45 cents

Conference on Space, Science, and Urban Life

Proceedings of a conference at Oakland, Calif., March 28-30, 1963, on the applicability of the national space program, and the knowledge resulting from aerospace research, to the problems of urban growth. Index. NASA SP-37 1963 254 pp. GPO \$1.75

Measurement of Thermal Radiation Properties of Solids

Joseph C. Richmond, Ed.

Proceedings of a symposium at Dayton, Ohio, September 5-7, 1962, sponsored by NASA, the Air Force, and the National Bureau of Standards. Index.

NASA SP-31 1963 587 pp. GPO \$3.50

Proceedings of the Image Intensifier Symposium

Proceedings of the symposium held at Fort Belvoir, Va., October 24-26, 1961, under the joint sponsorship of NASA and the U.S. Army Engineer Research and Development Laboratories. NASA SP-2 1962 252 pp. GPO \$1.50

Handbooks, Data Compilations, Charts, and Tables

Venus and Mars Nominal Natural Environment for Advanced Manned Planetary Mission Programs, 2d Edition

By Dallas E. Evans, David E. Pitts, and Gary L. Kraus

Numerical values for a nominal natural environment for application in studies of advanced planetary missions to Venus and Mars. The data compiled here provide a standard environment so that various mission and preliminary design studies will be based on realistic data and have a common basis for comparison of end results. The data in this revised edition differ from those of the first edition mainly as a result of the Mariner IV Mars flyby experimental results.

NASA SP-3016 1967 52 pp. CFSTI \$3.00

Handbook of the Physical Properties of the Planet Jupiter

By C. M. Michaux, et al.

This document summarizes observational knowledge of Jupiter through December 1965 and briefly outlines the results of many theoretical studies of the planet. Areas covered include: orbital elements, mass, diameter and shape, rotation, mean density, surface gravity, internal structure, temperature, radio-frequency radiation, atmospheric composition, structure, circulation, and satellites of Jupiter.

NASA SP-3031 1967 142 pp. GPO 60 cents

Thermodynamic Equilibrium in Prebiological Atmospheres of C, H, O, N, P, S, and Cl

By M. O. Dayhoff, E. R. Lippincott, R. V. Eck, and G. Nagarajan

The book presents the mathematical methods used and the computer program from which the tables were derived. Also, a survey of thermodynamic equilibrium states of ideal gas systems containing C, H, O, N, P, S, and Cl are discussed. Appendix I discusses applications with regard to the thermodynamic equilibria in planetary atmospheres. Appendix II discusses application with regard to the role of thermodynamic equilibrium in the inorganic origin of organic matter.

NASA SP-3040 1967 257 pp. CFSTI \$3.00

Handling and Use of Fluorine and Fluorine-Oxygen Mixtures in Rocket Systems

By Harold W. Schmidt

Fluorine's use in rocketry has been studied for nearly three decades at Lewis Research Center. Its reactivity and toxicity demand engineering perfection. The author, with the help of Jack T. Harper, has presented information now available about its properties, compatibility, and the requirements for its safe, intelligent use, for the guidance of designers, engineers, and scientists.

NASA SP-3037 1967 279 pp. GPO \$1.50

Tables of Interference Factors for Use in Correcting Data from VTOL Models in Wind Tunnels with 7 by 10 Proportions

By Henry H. Heyson

The tables give interference factors for models whose span is parallel to either the long or the short side of the wind tunnel. Instructions for the use of these values for semispan models are included.

NASA SP-3039 1967 649 pp. CFSTI \$3.00

Models of the Trapped Radiation Environment

Vol. I: Inner Zone Protons and Electrons

By James I. Vette

Vol. II: Inner and Outer Zone Electrons

By James I. Vette, Antonio B. Lucero, and Jon A. Wright

Vol. III: Electrons at Synchronous Altitudes

By James I. Vette and Antonio B. Lucero

These volumes are compilations of the results of a program sponsored by NASA and USAF for the purpose of defining a model of the radiation environment of the Earth. The first two volumes contain model environments for the lower altitude regions where trapping is relatively stable. The third volume presents a model of the Earth synchronous orbit at 19 300 nautical miles near the boundary of stable trapping where the particles fluxes vary through several orders of magnitude.

Vol. I NASA SP-3024 1966 55 pp. CFSTI \$3.00

Vol. II NASA SP-3024 1966 88 pp. CFSTI \$3.00

Vol. III NASA SP-3024 1966 107 pp. CFSTI \$3.00

Electron Densities and Scale Heights in the Topside Ionosphere:

Alouette I Observations Over the American Continents

Vol. I: November, December 1962, and January 1963

Vol. II: March and May 1963

Vol. III: June, July, September, and October 1963

By Kwok-Long Chan, Lawrence Colin, and John O. Thomas

Data on electron density and plasma at various heights and times obtained by the satellite. The measurements were made over the American continents at a sunspot minimum epoch of the solar cycle. The first two volumes contain winter and summer tabulations, and the third has tabulations for the equinox period. A fourth volume is planned.

Vol. I NASA SP-3027 1966 504 pp. CFSTI \$3.00

Vol. II NASA SP-3032 1966 607 pp. CFSTI \$3.00

Vol. III NASA SP-3033 1967 584 pp. CFSTI \$6.25

An additional volume presents data obtained over Hawaii during the winter of 1962-1963 and the summer of 1963. Prepared by Lawrence Colin and Kwok-Long Chan.

NASA SP-3038 1967 283 pp. CFSTI \$3.00

Electron Densities and Scale Heights in the Topside Ionosphere:

Alouette I Observations in Midlatitudes

By John O. Thomas, M. Rycroft, and L. Colin

Contains data on electron density and plasma scale height at a series of heights and times. The tabulated data were computed from ionograms recorded at Stanford University in the summer and winter of 1963-64. The calculations were programmed for an electronic digital computer at Ames Research Center NASA SP-3026 1966 614 pp. CFSTI \$3.00

Space Measurement Survey: Instruments and Spacecraft,

October 1957-March 1965

Henry L. Richter, Jr., Ed.

This volume contains fact sheets on most of the satellites and probes launched, from Sputnik 1 through Gemini III. Information includes orbital parameters, instruments carried, and experimental objectives of each orbital or deep space probe. A second section presents a discussion of each flight organized by experiment or instrumentation, including ionizing radiation, photon measurements, aeronomy measurements, magnetic fields, and micrometeoroid detectors.

NASA SP-3028 1966 1008 pp. CFSTI \$3.00

Additional Stopping Power and Range Tables for Protons, Mesons, and Electrons

By Martin J. Berger and Stephen M. Seltzer

This report is a supplement to earlier tabulations which it extends. Data are given for liquid H₂, LiF, Si, Ge, propane and freon. It also corrects tables for electrons in muscle and bone in earlier volumes. NASA SP-3036 1967 40 pp. CFSTI \$2.00

The previous reports cited above were: "Tables of Energy Losses and Ranges of Heavy Charged Particles," NASA SP-3013 (1964 131 pp. CFSTI \$3.00); and "Tables of Energy Losses and Range of Electrons and Positrons," NASA SP-3012 (1964 127 pp. CFSTI \$3.00), by the same authors and Walter H. Barkas.

Thermodynamic, Transport, and Flow Properties for the Products of Methane Burned in Oxygen-Enriched Air

By Bobby H. Croom and Edward W. Leyhe

Results of calculations to determine the composition and the thermodynamic, transport, and flow properties of gas mixtures. Properties are computed for methane burned in air enriched with oxygen so as to maintain approximately 20 percent oxygen in the combustion products. NASA SP-3035 1966 89 pp. CFSTI \$3.00

Space Materials Handbook:

Supplement 1 to the Second Edition, Space Materials Experience

By John B. Rittenhouse and John B. Singletary

A survey of materials used in the construction of successfully orbited spacecraft for which information has become available since the completion of the second edition of the *Space Materials Handbook* (ML-TDR-64-40, available from the Defense Documentation Center). Selection of materials for optimum performance is discussed in terms of the effects of the space environment. Glossary and indexes, including a cumulative index which also covers information contained in the Handbook.

NASA SP-3025 1966 263 pp. CFSTI \$3.00

Calculations of Thermal Field Emission for a Terminated Image Potential

By James F. Morris

Computed properties are presented that characterize electron emission with a terminated image potential for fields from 10⁶ to 10⁸ volts per centimeter, temperatures from 0° to 3000° K, work functions from 1 to 8 volts, and Fermi levels from 1 to 15 electron volts.

NASA SP-3023 1966 610 pp. CFSTI \$3.00

Magnetic Fields Due to Solid and Hollow Conical Conductors

By James C. Stoll, Peggy L. Yohner, and James C. Laurence

The axial and radial components of the magnetic field produced by a solid, finite-length conical conductor with a constant azimuthal current density were derived, and numerical results were computed for several values of the half-cone angle. The triple integrals giving the field values were integrated twice analytically; the third integration was done numerically on electronic computers using Gaussian integration. Axial and radial magnetic fields due to hollow conical coils or hollow frustum coils of finite thickness can be obtained from these solid-cone fields by superposition.

NASA SP-3022 1965 132 pp. CFSTI \$3.00

**Charts for Equilibrium and Frozen
Nozzle Flows of Carbon Dioxide**
By George G. Mateer and Victor L. Peterson

Results are presented for total pressures ranging to 1000 atmospheres and total enthalpies ranging to 55 kilojoules per gram. The properties of temperature, pressure, density, velocity, dynamic pressure, Mach number, Reynolds number, molecular-weight ratio, and species concentrations are presented in charts. Temperature, pressure ratio, and density ratio across normal shock waves in a nozzle are also included.

NASA SP-3019 1965 78 pp. CFSTI \$3.00

**Charts for Equilibrium and Frozen Flows
Across Plane Shock Waves in Carbon Dioxide**
By Craig D. Simcox and Victor L. Peterson

In this work, the flow was assumed to be in equilibrium and the chemistry to be frozen with molecular vibrations either not excited or fully excited. Results are presented in graphical form at ambient pressures ranging from 10^{-7} to 10 atmospheres, and for speeds ranging from 1 to 16 km/sec.

NASA SP-3018 1965 129 pp. CFSTI \$3.00

**Equilibrium Thermodynamic Properties
of Carbon Dioxide**

By Harry E. Bailey

Entropy, enthalpy, pressure, and speed of sound of carbon dioxide computed for wide ranges of temperature and density are presented graphically. The temperature range is $250^{\circ}\text{ K} \leq T \leq 25\,000^{\circ}\text{ K}$ ($\Delta T = 250^{\circ}\text{ K}$). The density range is $-7.0 \leq \log \rho/\rho_0 \leq +3.0$ ($\Delta \log \rho/\rho_0 = 0.2$).

NASA SP-3014 1965 66 pp. CFSTI \$3.00

**Charts for Equilibrium Flow Properties
of Carbon Dioxide in Hypervelocity Nozzles**

By Leland H. Jorgensen and Robert J. Redmond

Conjecture on the composition of the Venusian and Martian atmospheres, as well as interest in the problems of flight within these atmospheres, has prompted this investigation. For initial stagnation pressures from 1 to 1000 atmospheres and stagnation enthalpies from 400 to 20 000 Btu/lb, nozzle-flow properties for equilibrium carbon dioxide have been computed and plotted. Properties charted as a function of Mach number are as follows: temperature, pressure, density, speed, area ratio, dynamic pressure, stagnation-point pressure coefficient, Reynolds number, isentropic exponent, and molecular-weight ratio. Temperatures, pressures, and densities across normal shock waves are also charted, and weight-flow rate is plotted as a function of stagnation enthalpy.

NASA SP-3015 1965 71 pp. CFSTI \$3.00

**Charts for Approximate Thermodynamic
Properties of Nitrogen-Oxygen Mixtures**

By Bruce Fowler and Ronald Brown

The purpose of this publication is to present data, determined by one consistent approach, on the thermodynamic properties of nitrogen and three nitrogen-oxygen compositions and the dimensionless speed-of-sound parameter for each. These properties have been calculated over a temperature range from 200° to $15\,000^{\circ}\text{ K}$ for a pressure range from 10^{-4} to 10^2 atmospheres. The data are presented in a combination of Mollier charts and tables, so that aerodynamic expansions can be performed. The results, which agree closely with more rigorous calculations, are considered suitable for engineering purposes.

NASA SP-3017 1965 116 pp. CFSTI \$3.00

**Equilibrium Thermodynamic Properties
of Three Engineering Models of the Martian Atmosphere**
By Harry E. Bailey

Entropy, enthalpy, pressure, and sound speed of three carbon dioxide-nitrogen mixtures are presented graphically for wide ranges of temperature and density. The temperature range is $250^{\circ}\text{ K} \leq T \leq 25\,000^{\circ}\text{ K}$ ($\Delta T = 250^{\circ}\text{ K}$). The density range is $-7.0 \leq \log \rho/\rho_0 \leq 3.0$ ($\Delta \log \rho/\rho_0 = 0.2$). The chemical compositions of the three mixtures correspond to those selected as engineering models of the Mars atmosphere in NASA TN D-2525.

NASA SP-3021 1965 162 pp. CFSTI \$3.00

**Charts of Isentropic Exponent as a Function
of Enthalpy for Various Gases in Equilibrium**
By Leland H. Jorgensen

For enthalpies to $28\,000\text{ Btu/lb}$ and pressures from 10^{-3} to 10^2 atmospheres, curves of isentropic exponent as a function of enthalpy and speed are presented for equilibrium air, nitrogen, carbon dioxide, and a composition of 20 percent CO_2 and 80 percent N_2 (by volume). For a pressure of 1 atmosphere, curves are also presented for compositions of 10 percent CO_2 -90 percent N_2 and for 50 percent CO_2 -50 percent N_2 .

NASA SP-3020 1965 10 pp. CFSTI \$3.00

**Thermodynamic and Transport Properties
for the Hydrogen-Oxygen System**
By Roger A. Svehla

The properties calculated include enthalpy, entropy, molecular weight, heat capacity, isentropic exponent, composition, viscosity, thermal conductivity, and Prandtl number and Lewis number for chemical-equilibrium conditions. Also included are frozen heat capacity, frozen thermal conductivity, and frozen Prandtl number, all calculated with the equilibrium composition. Results are presented in tabular form and, in some cases, in graphical form.

NASA SP-3011 1964 419 pp. CFSTI \$3.00

**Tables for Supersonic Flow Around Right
Circular Cones at Small Angle of Attack**

Results are presented for cone angles from 2.5° to 30° in regular increments of 2.5° . The calculations were performed using the theory of Stone, which yields results in a wind-fixed coordinate system. However, all results have been transformed into a body-fixed coordinate system.

NASA SP-3007 1964 422 pp. GPO \$2.25

Tables of the Complex Fresnel Integral
By C. William Martz

The complex Fresnel integral defined by

$$\int_0^{z+iy} \exp \frac{i\pi u^2}{2} du$$

is evaluated by means of Taylor's series expansions. The real and imaginary parts, accurate to five significant figures, are tabulated essentially throughout the complex plane, except in the regions $xy < -6.8$. Tabulation intervals in the x -direction are 0.02 for $0 \leq X \leq 10$, and 0.01 for $10 \leq X \leq 20$. Similar intervals apply in the y and $-y$ directions. An error analysis is presented of the methods used to evaluate the integrals.

NASA SP-3010 1964 298 pp. CFSTI \$3.00

Tables of Flow Properties of Thermally Perfect Carbon Dioxide

and Nitrogen Mixtures

By William Patrick Peterson

Equations, tables, and figures for use in the analysis of flow of carbon dioxide and mixtures of carbon dioxide and nitrogen. Tables of gas properties as functions of temperature and one-dimensional, normal, and oblique-shock parameters as functions of Mach number are presented for Mach numbers up to 12.7. The parameters dependent on Mach number are tabulated for stagnation temperatures from 1000° to 3000° R. Condensation Mach numbers are also given.

NASA SP-3009 1964 113 pp. CFSTI \$3.00

Thermodynamic Properties and Mollier Chart

for Hydrogen From 300 K to 20 000 K

By Robert F. Kubin and Leroy L. Presley

The calculated properties for pressures from 10^4 to 10^8 atmospheres include energy, enthalpy, entropy, specific heats, and equilibrium constants for dissociation and ionization, chemical composition, density, compressibility, and speed of sound. Results are presented in tabular form and in the form of a Mollier diagram, and are considered to be suitable for engineering purposes.

NASA SP-3002 1964 63 pp CFSTI \$3.00

Tables of the Composition, Opacity, and

Thermodynamic Properties of Hydrogen at High Temperatures

By N. L. Krascella

All data are tabulated for 14 total pressures between 1 and 1000 atmospheres and for 21 temperatures between 3000° and 200 000° R. Spectral-absorption coefficients are tabulated for 33 wave numbers between 1000 and 400 000 cm^{-1} at each pressure and temperature. The equations employed in making the theoretical calculations are listed, and typical examples of the tabulated data are presented in graphical form.

NASA SP-3005 1963 185 pp. CFSTI \$3.00

Tables for Supersonic Flow Around Right Circular Cones at Zero Angle of Attack

By Joseph L. Sims

Results are presented for cone angles from 2.5° to 30° in regular increments of 2.5°. The calculations were performed using the Taylor and Maccoll theory. Numerical integrations were performed using the Runge-Kutta method for second-order differential equations. The desired free-stream Mach number was obtained to six or more significant figures in all calculations. The data listed in this report are essentially the same as those of Zdenk Kopal's Tables of Supersonic Flow Around Cones.

NASA SP-3004 1964 421 pp. GPO \$2.25

Handbook of Space-Radiation Effects

on Solar-Cell Power Systems

By William C. Cooley and Robert J. Janda

Areas of space-radiation effects covered in this handbook are: (1) radiation damage to solar cells, (2) correlation of satellite test data on solar-cell performance, (3) design methods for solar-cell power systems, (4) radiation effects on solar-cell cover slide materials and adhesives, (5) space-radiation effects on transistors and diodes, and (6) summary of the space-radiation environment.

NASA SP-3003 1963 120 pp. CFSTI \$3.00

**Energy Spectra and Angular Distributions
of Electrons Transmitted Through Sapphire (Al_2O_3) Foils**
By Martin J. Berger and Stephen M. Seltzer

Monte Carlo results are presented, in the form of 72 tables, for the transmission of electrons with energies between 1 and 8 MeV through sapphire foils. Two types of beam geometry are treated for all source energies: (a) perpendicular incidence and (b) beams with an initial cosine-law angular distribution. For a source energy of 2 MeV, various incident beam obliquities are also treated. The physical factors taken into account include the energy losses due to collisions with atomic electrons, the mean energy loss due to bremsstrahlung, and the angular deflections and path detours due to multiple Coulomb scattering by atoms.

NASA SP-3008 1964 107 pp. CFSTI \$3.00

**Thermodynamic Properties to 6000° K for 210 Substances
Involving the First 18 Elements**

*By Bonnie J. McBride, Sheldon Heimel, Janet G. Ehlers,
and Sanford Gordon*

Consistent tables for gaseous and condensed species give the following functions for the standard state: heat capacity at constant pressure, sensible enthalpy, entropy, sensible free energy, and the sum of sensible enthalpy and chemical energy at 0° K, as well as values of enthalpy changes and logarithms of equilibrium constants.

NASA SP-3001 1963 328 pp. CFSTI \$3.00

Bioastronautics Data Book

Paul Webb, Ed.

This publication is for designers of aerospace vehicles and equipment. It contains carefully selected applied research data from the life sciences in consistent engineering units, accompanied by metric scales. Index. NASA SP-3006 1964 400 pp. GPO \$2.25

Histories and Chronologies

This New Ocean: A History of the Project Mercury

By Loyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander

A highly readable, well-documented story of Project Mercury, the first U.S. manned space flight program, which spanned 55 months from authorization through Cooper's 22-orbit flight in May 1963 and which, at one time or another, involved more than 2 million people. A wealth of background information concerning the events and decisions that led up to manned space exploration is given, and each of the six Mercury flights is described in detail.

NASA SP-4201 1966 680 pp. GPO \$5.50

An Administrative History of NASA, 1958-1963

By Robert L. Rosholt, with a Foreword by James E. Webb

The first five chapters of this study cover the antecedents and first years of the National Aeronautics and Space Administration; the remaining four deal with the change in political administration and the acceleration of the space program in 1961, and with the organizational consequences through 1963. Emphasis is on organizational structure and administrative procedures, including intra-agency procedures, personnel, finance, and procurement.

NASA SP-4101 1966 381 pp. GPO \$4.00

Space Medicine in Project Mercury

By Mae Mills Link

This volume examines the development of NASA's fund of space-medicine information and experience. It also shows how NASA was able to draw upon the vast and rich resources of the Air Force, the Navy, other Government agencies, industry, and academic and private research institutions to develop life-support systems to protect man against the stresses of launch, orbit, reentry, and impact throughout the Mercury program. Index.

NASA SP-4003 1965 198 pp. GPO \$1.00

Astronautics and Aeronautics, 1965

Chronology on Science, Technology, and Policy

Events, statements, and other information pertinent to aeronautical and space affairs compiled for ready reference. Sources include newspapers, speeches, agency releases, magazine articles, and editorials. An extensive index.

NASA SP-4006 1966 681 pp. GPO \$5.50

Under the same title similar chronologies are available for 1964 and 1963:

For 1964, NASA SP-4005 1965 527 pp. GPO \$1.75

For 1963, NASA SP-4001 1964 610 pp. GPO \$2.00

Project Mercury: A Chronology

By James M. Grimwood

A listing of major events in the first U.S. manned space-flight program, from preliminary discussions of Earth satellite vehicles through Astronaut Cooper's 22-orbit flight in May 1963. Index.

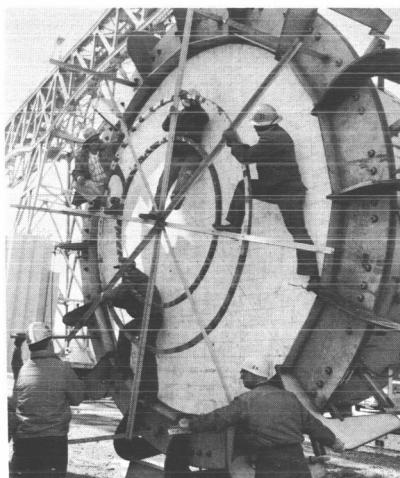
NASA SP-4001 1963 238 pp. GPO \$1.50

Technology Utilization Series

High-Velocity Metalworking

This is a comprehensive survey by the Midwest Research Institute of the new state of the arts of electromagnetic, electrohydraulic, pneumatic-mechanical, and explosive metalworking. By these processes, complex, finished surfaces, and close-tolerance parts in a great range of sizes can now be produced with less waste than by more conventional methods. The authors explain the fundamentals, point out the limitations, and emphasize the varied potentialities of all four processes. Separate chapters cover die design and material behavior at high strain rates. There are 290 illustrations and 192 references.

NASA SP-5062 1967 183 pp.
GPO \$1.25



Properties and Current Applications of Magnesium-Lithium Alloys

By R. J. Jackson and P. D. Frost

This is a compilation of engineering information on magnesium-lithium alloys. The mechanical properties and metallurgical characteristics for standard and developmental alloys are included. Various processing techniques, including cleaning and finishing, fabrication, casting, and joining, are discussed.

NASA SP-5068 1967 54 pp. GPO 40 cents

NASA Contributions to Metals Joining

By W. J. Reichenecker and J. Heuschkel

This survey covers the many developments in joining metals by mechanical fasteners, soldering, brazing, welding, and plasma spray bonding, reported between 1962 and mid-1965. The material reviewed is related to current hardware problems. Included are data on novel tooling techniques, process development and applications, base metal and filler metal relationships, and innovations in joining mechanisms.

NASA SP-5064 1967 141 pp. GPO 60 cents

Vacuum Switchgear

By W. S. Emmerich

Technological advances in space work have increased the possibility of operating electrical switches in vacuum, which would offer significant advantages. The manager of Westinghouse plasma programs has reviewed and evaluated this work. Adhesion mechanisms, the effect of surface preparation, pressure measurements, cathode and arc phenomena, and hardware developments are described in this survey for electric power engineers.

NASA SP-5063 1967 36 pp. GPO 35 cents

Assessing Technology Transfer

By Richard L. Lesser and George J. Howick

An abridgement of a report prepared for the National Commission on Technology, Automation, and Economic Progress, which was established in August 1964. Considered are such questions as the value of technology transfer as a national goal, the sufficiency of sources for such transfer, incentives and barriers, transfer mechanisms or channels used to date, and elements essential to effective transfer. The authors conducted depth interviews with persons in Government agencies that have technology-transfer and information dissemination programs.

NASA SP-5067 1966 121 pp. GPO 50 cents

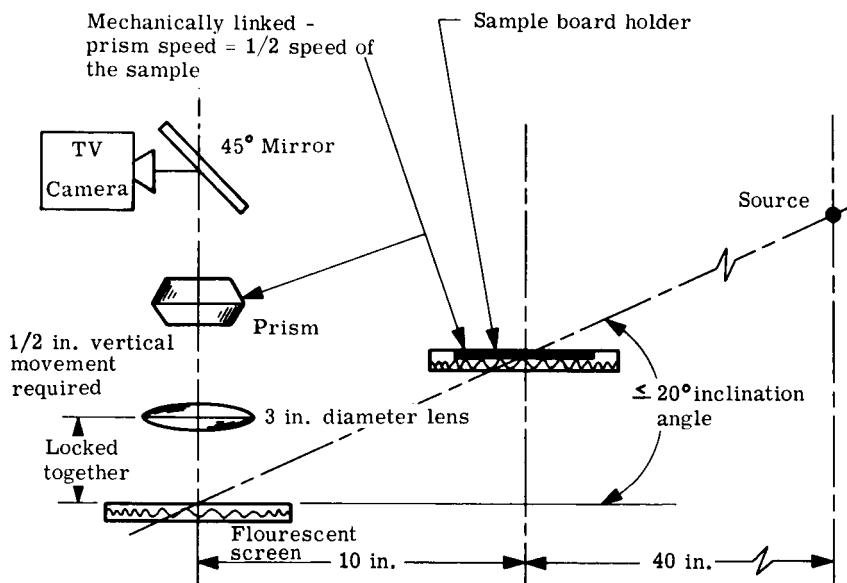
Adhesives, Sealants, and Gaskets

By R. B. Perkins and S. N. Glarum

A survey of adhesives, sealants, and gaskets developed to operate in the extreme environment of space that will interest specialists in the subject. The reliability of materials used in a liquid oxygen environment is emphasized. The following are described in detail: polymeric fillers in adhesives, elastomeric films in glue lines, epoxy ester adhesives, sealants for low-temperature service, gasket design, and measurement of stress in gaskets.

NASA SP-5066 1967 63 pp. GPO 25 cents

Nondestructive Testing: Trends and Techniques



The proceedings of the Second Technology Status and Trends Symposium, in October, 1966, at the Marshall Space Flight Center. Technical papers discuss the examination of multilayer printed wiring boards by laminography, evaluation of adhesive bonded composite materials, ultrasonic analysis of aluminum, and X-ray television techniques for nondestructive testing. The nine papers in this newsy publication are highly illustrated.

NASA SP-5082 1967 123 pp. GPO 55 cents

Cumulative Index to NASA Tech Briefs 1963-1966

Tech Briefs are short announcements of innovations and developments by NASA research centers, contractors, and subcontractors that are potentially applicable to problems arising outside as well as within the aerospace industry. A cumulative index containing abstracts of these briefs is published annually. This one lists nearly 2000 Tech Briefs, any one of which may be purchased for 15 cents from the Clearinghouse for Federal Scientific and Technical Information. Subjects and the originating sources are indexed.

NASA SP-5021(04) 1966 91 pp. CFSTI \$3.00

Commercial Potentials of Semipermeable Membranes

By Sidney B. Tuwiner, Ernest J. Henley, and H. Kenneth Staffin

A survey of spacecraft-stimulated progress in producing and using membranes, including advances which have varied but impressive economic potentialities. Presented are data on new techniques and principles, membrane applications in batteries, advances in material science, level control in batteries, fuel cells, and various separation processes.

NASA SP-5061 1967 45 pp. GPO 35 cents

Magnetic Tape Recording Technology

By Skipwith W. Athey

A survey of the entire range of recorder technology, with emphasis on two aspects of development in which NASA has played an important part. One is the area of miniature severe-environment tape recorders, for use in satellites and space probes. The other area particularly explored in this publication is that of commercial, ground-based tape recorders for acquiring telemetry data and for related purposes. Index.

NASA SP-5038 1966 326 pp. GPO \$1.25

Solid Lubricants

By M. E. Campbell, John B. Loser, and Eldon Sneegas

A survey of the state of development of solid lubricants, including types and specifications, commercial applicability, cost factors, theory, and new developments in the field. Methods of evaluating solid film lubricants and the test apparatus are also discussed.

NASA SP-5059 1966 115 pp. GPO 50 cents

A "Bibliography on Solid Lubricants" also has been published as NASA SP-5037 (1966 14 pp. CFSTI \$3.00).

NASA Contributions to the Technology of Inorganic Coatings

By Jerry D. Plunkett

A survey of NASA's contributions in the areas of thermophototropic coatings, thermal control for space vehicles, solid-lubrication coatings, thermal-insulation coatings, application of coatings to substrates, measurement of coating optical properties, and refractory metal oxidation-resistant coatings.

NASA SP-5014 1964 268 pp. GPO \$1.00

Brazing and Brazing Alloys, a Bibliography

Identifies the current literature on brazing and brazing alloys to provide industry with summaries of information obtainable in the aerospace field.

NASA SP-5026 1967 52 pp. CFSTI \$1.00

Mathematical Computer Programs

Several mathematical programs and programing techniques for digital computers which are available through the NASA Technology Utilization program are outlined. Although the functions that the programs perform are not new, and similar programs are available in many large computer center libraries, the collection may be useful to centers with limited systems libraries and for instructional purposes for new computer operators.

NASA SP-5069 1967 26 pp. CFSTI \$1.00

Nonglassy Inorganic Fibers and Composites

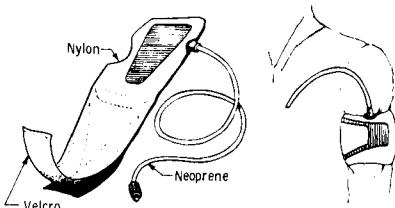
By *Cameron G. Harman*

This report presents information about non-metallic, inorganic whiskers and fibers, and composites that may be useful to industry. Emphasis is given to boron carbide whiskers, boron filaments, refractory ceramic fibers, and metal-fiber-reinforced metallic composites. This is a Southwest Research Institute report with 61 references.

NASA SP-5055 1966 44 pp. GPO 35 cents

NASA Contributions to Cardiovascular Monitoring

This survey describes new aids to measuring blood pressure, sensing external manifestations of cardiovascular forces, and attaching electrodes to the human body. It emphasizes non-space uses of technology developed for manned space flights. NASA SP-5041 1966 43 pp. GPO 25 cents



Tungsten Powder Metallurgy

By *V. D. Barth and H. O. McIntire*

Prepared for NASA under contract by Battelle Memorial Institute, this report summarizes recent developments in tungsten-powder metallurgy technology as related to space vehicles and the less traditional applications. The customary use of tungsten as a carbide or as a minor alloying element is not considered.

NASA SP-5035 1965 40 pp. GPO 35 cents

Metal-Forming Techniques

By *Ilia I. Islamoff*

Outlines recent metal-forming methods for sheet and plate materials used by the aircraft and aerospace industries, and describes particularly the techniques employed at present, some of which, like magnetic forming and hot-drape forming, are in experimental stages.

NASA SP-5017 1965 52 pp. GPO 40 cents

Some New Metal and Metal-Ceramic Composites

This report is designed to show industrial management the current state of development of some composite materials, including dispersion-strengthened composites, fiber composites, and reinforced ceramics. Basic concepts, problem areas, practical considerations, economic factors, and commercial application are discussed.

NASA SP-5060 1966 26 pp. GPO 25 cents

Vibrating Diaphragm Pressure Transducer

This report, prepared under contract for NASA by Southwest Research Institute, describes the vibrating diaphragm pressure transducer developed at Ames Research Center for use in high-velocity wind tunnels. The instrument is used for sensing absolute gas pressures over the range of approximately 10^{-5} to 10^3 mm Hg. With little or no modification, the transducer can be used as a differential capacitor pressure transducer, an electrometer input device, a magnetic damping measuring device, and an accurate multiplier for use with electronic analog computers.

NASA SP-5020 1966 27 pp. GPO 30 cents

Selected Welding Techniques, Parts I and II

Descriptions and illustrations of tools and techniques used in welding aluminum sheet and plate at the Marshall Space Flight Center.

Part I NASA SP-5003 1964 25 pp. GPO 30 cents

Part II NASA SP-5009 1964 34 pp. GPO 30 cents

A "Bibliography on Welding Methods" is also available as NASA SP-5024 (1966 28 pp. CFSTI \$3.00).

Welding for Electronic Assemblies

This handbook covers the theory, requirements and fundamental techniques of interconnecting electronic components by resistance spot welding. A thorough understanding of the theory of resistance spot welding along with good workmanship and process control are the factors necessary to attain the required reliability. Glossary.

NASA SP-5011 1964 81 pp. GPO 40 cents

Bibliography on Electromechanical Transducers

Annotated bibliography of current literature on the applications and uses of electro-mechanical transducers, with subject and author indexes. Material selected by ASTRA, Midwest Research Institute.

NASA SP-5036 1966 20 pp. CFSTI \$3.00

Selected Casting Techniques

Outlines a construction method by which wind-tunnel models of both simple and complex configuration can be produced rapidly at reduced cost. An interesting casting and plasticizing technique developed by Langley Research Center that may be applied to items not related to the aircraft industry.

NASA SP-5044 1966 21 pp. CFSTI \$3.00

Suggested Method for Plating Copper on Aluminum

Describes the successful application of the phosphate anodizing process in copperplating commercially pure aluminum and several aluminum alloys. Lists the advantages, as well as one disadvantage, of this procedure compared with the zincate process in current industrial use.

NASA SP-5025 1966 9 pp. GPO 20 cents

Selected Electronic Circuitry

Describes specific innovations derived from space programs that appear to be useful generally. Information is included on amplifier, oscillator, multi-vibrator, wave-shaping, temperature-compensation, and control circuits. Special computer circuits are also included.

NASA SP-5046 1967 100 pp. GPO 70 cents

A Technique for Joining and Sealing Dissimilar Materials

Describes a boltless attachment-and-sealing method used in cryogenic research at Lewis Research Center. The method features configured male and female members with a third material in the resulting cavity. Under the NASA Technology Utilization Program, this fastening method has been studied for potential use in industrial products and processes. The study suggests that the concept can provide the basis for a family of fastening and sealing methods. Representative areas of design use are presented.

NASA SP-5016 1965 8 pp. CFSTI \$3.00

Microelectronics in Space Research

Provides information on the contributions to the microelectronics field that have originated in NASA research programs. Also includes a review of the status of microelectronics, in which the limitations of the various technologies are highlighted. Considerable emphasis has been placed on silicon integrated-device technology, because of its importance. Microminiaturization aimed solely at reducing the size of components and circuits is not considered.

NASA SP-5031 1965 130 pp. GPO 60 cents

The Electromagnetic Hammer

This report describes a method of using a pancake electromagnetic coil driven by electric-discharge equipment to smooth out nonferrous metal components such as welded rocket fuel tanks, gore segments, and bulkheads. NASA SP-5034 1965 22 pp. GPO 25 cents

Plasma Jet Technology

Compiled by P. R. Dennis, C. R. Smith, D. W. Gates, and J. B. Bond

This survey emphasizes the industrial potential of plasma generators in the testing, coating, and spraying of materials, in chemical synthesis, and in other industrial operations. It includes accounts of NASA contributions to such technology and the instrumentation involved, and lists NASA plasma-arc facilities.

NASA SP-5033 1965 200 pp. GPO \$1.00

Advanced Valve Technology

By Kenneth D. May

Today's valve problem areas are recognized, research and development activities in these areas discussed, and the latest trends and techniques reported. Glossary.

NASA SP-5019 1965 182 pp. CFSTI \$3.00

Handling Hazardous Materials

By D. R. Cloyd and W. J. Murphy

A report on highly reactive materials (such as liquid hydrogen, pentaborane, fluorine, and hydrazine) studied in the search for fuels and oxidizers for spacework. Methods for safe handling of these materials are discussed.

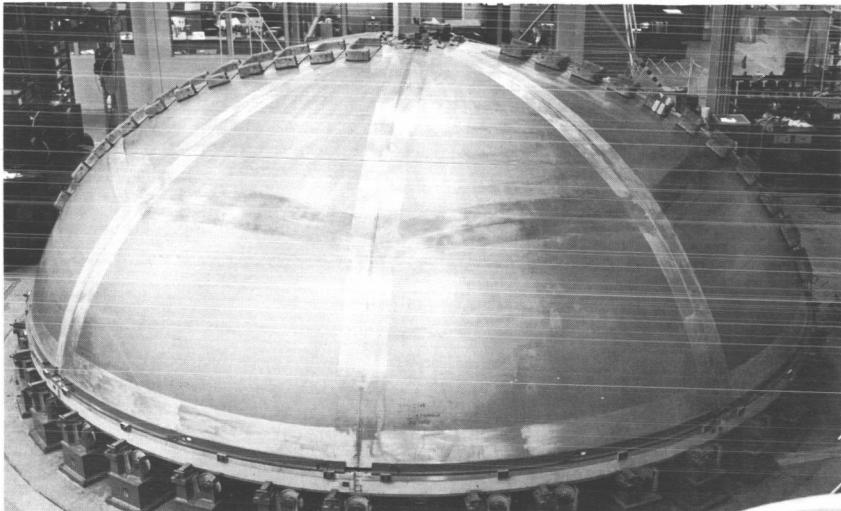
NASA SP-5032 1965 96 pp. GPO 45 cents

Space Batteries

Handbook containing descriptions of three sealed battery systems for spacecraft, and a discussion of how test-data information may be shared among space contractors.

NASA SP-5004 1964 53 pp. GPO 25 cents

Selected Shop Techniques



A handbook prepared especially for machinists, mechanics, and those working in related crafts, on the premise that "although no two problems are identical, they may certainly be similar." It describes how fabrication obstacles were overcome by improvisation, by creating new tools, and sometimes by applying an old and may be all-but-forgotten technique to a new field.

NASA SP-5010 1965 105 pp. GPO 60 cents

Technical and Economic Status of Magnesium-Lithium Alloys

By Paul D. Frost

Magnesium-lithium alloys, their general characteristics, current applications, and economic considerations for their future use. One objective is to report on the progress being made in the application of the new ultralight magnesium-lithium alloys in the space industry and to disseminate this information to those organizations not acquainted with the alloys and their applications. The second objective is to speculate on possible future usefulness of the alloys and to define technical and economic requirements for commercial use.

NASA SP-5028 1965 45 pp. GPO 25 cents

Micropower Logic Circuits

By John C. Sturman

Illustrated descriptions of a number of digital logic circuits developed primarily to fill a need for very-low-power logic systems in space vehicles but which can easily be adapted for specific applications in nonspace computer systems, numerically controlled machine tools, measuring instrumentation, remote controls and alarm systems, high-fidelity radio and recording systems, and television receivers.

NASA SP-5022 1965 15 pp. CFSTI \$3.00

Medical and Biological Applications of Space Telemetry

A description of biotelemetry systems directed toward expediting more widespread use of such devices. Glossary.

NASA SP-5023 1965 66 pp. GPO 45 cents

Reliable Electrical Connections, 3d Edition
Prepared under the direction of James A. Gay, Jr.

Diagrams, photographs, and detailed instructions covering dependable techniques of different kinds of electrical connections. NASA SP-5002 1963 67 pp. CFSTI \$3.00

Effects of Low Temperatures on Structural Metals

Testing procedures are described and test data are tabulated in this report. Cryogenic properties are presented in graphic form and discussed for alloy steels and alloys of aluminum, nickel, titanium, and magnesium.

NASA SP-5012 1964 55 pp. GPO 40 cents

Elastic Orifices for Gas Bearings

Test data indicate superiority of such a system over pressurized liquid and rolling-contact bearing systems.

NASA SP-5029 1965 11 pp. GPO 20 cents

Precision Tooling Techniques

Describes novel tooling techniques and devices, with possible industrial applications, developed at NASA's Marshall Space Flight Center.

NASA SP-5013 1964 25 pp. GPO 25 cents

Selected Machining and Metal Fabricating Technology

Contains shop hints for metal fabricators and those concerned with machining tools and techniques, fastening devices, assembly tools and techniques, and layout and inspection aids.

NASA SP-5065 1967 26 pp. GPO 25 cents

Conference on Selected Technology for the Petroleum Industry

A conference held at Lewis Research Center, December 8-9, 1965, to acquaint representatives of the petroleum industry with new technology resulting from the space effort. Choice of the topics was guided by a series of meetings between Lewis staff members and petroleum specialists.

NASA SP-5053 1966 169 pp. GPO \$1.25

Symposium on Technology Status and Trends

Proceedings of a conference at Huntsville, Ala., April 21-23, 1965, sponsored by the Technology Utilization Office of Marshall Space Flight Center to familiarize representatives of nonaerospace industry with space innovations.

NASA SP-5030 1966 248 pp. GPO \$1.50

Conference on New Technology

Proceedings of a conference at Lewis Research Center, June 4-5, 1964, to discuss ways of transferring applicable space-research knowledge to the industrial community.

NASA SP-5015 1964 156 pp. GPO \$1.00

Transforming and Using Space-Research Knowledge

Ten papers selected from a symposium and workshop sponsored by NASA and the University of California, Los Angeles, June 2, 1964.

NASA SP-5018 1964 110 pp. GPO 70 cents

Management, Evaluation, and Analysis Standards

An Introduction to the Evaluation of Reliability Programs

By D. S. Liberman and A. J. Slechter

A basic orientation to the task of evaluating the effectiveness of a reliability program is presented. Primary emphasis is devoted to discussing the assurance task as it relates to project requirements and resources, and to describing the factors which determine effectiveness in program implementation.

NASA SP-6501 1967 67 pp. CFSTI \$3.00

Structural Systems and Program Decisions

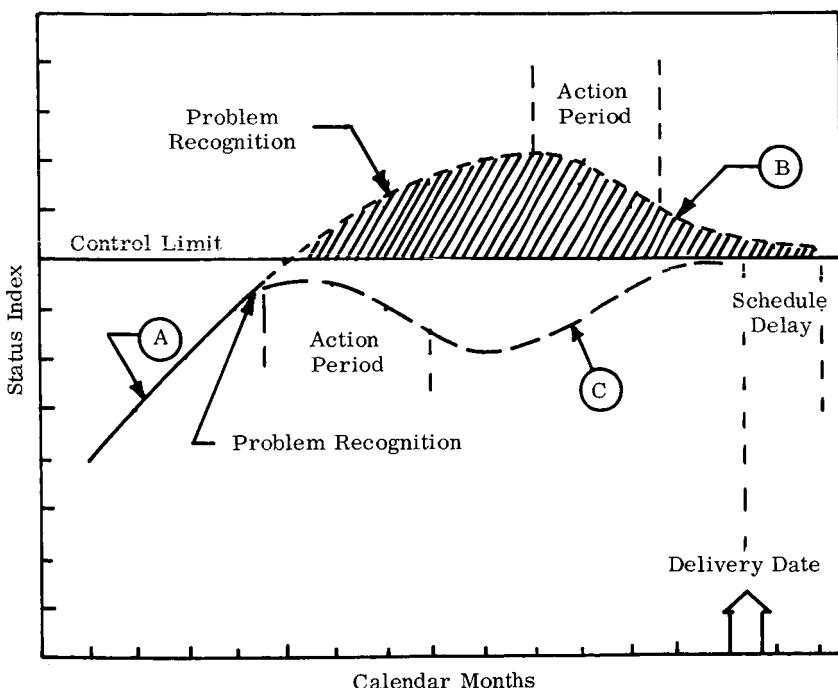
Two volumes written for decision-makers who must assimilate, validate, and interpret changes in baseline requirements on vehicle programs. This study presents a computer program designed to help management rapidly assess the impact of design criteria.

Vol. 1 NASA SP-6008 1966 214 pp. CFSTI \$3.00
Vol. 2 NASA SP-6008 (01) 1966 386 pp. CFSTI \$3.00

Forecasts and Appraisals for Management Evaluation

Two volumes intended primarily for those responsible for the administration, design, development, manufacture, and test of the Apollo system. Mathematical models, performance relationships, and a user's guide are appendixes to the second volume.

Vol. 1 NASA SP-6009 1966 220 pp. CFSTI \$3.00
Vol. 2 NASA SP-6009 (01) 1966 370 pp. CFSTI \$3.00



Weight/Performance Management Survey Manual

An Apollo Program Office Manual providing procedures for a management assessment of contractor activities, performance, and effectiveness of the management system. It provides a tool for determining corrective action.

NASA SP-6006 1965 31 pp. CFSTI \$3.00

Electrical Power Management Survey Manual

Procedures for a management audit of NASA Apollo Program contractor activities. It assesses performance toward objectives, evaluates effectiveness of the management system, and, where weaknesses exist, provides a tool for determining corrective action. This amplifies Electrical Power Management Standard CM019-000-1, June 15, 1965.

NASA SP-6007 1965 31 pp. CFSTI \$3.00

Electrical Power Management Standard

This document is a standard for all Apollo procurement actions. It establishes a system for the management and reporting of electrical power source, load, and distribution properties of space vehicles. Its demand will probably be limited to OMSF centers and Headquarters offices. Its use is similar to that of SP-6004 noted below.

NASA SP-6005 1965 31 pp. CFSTI \$3.00

Mass Properties Standard

This publication establishes a system for the management of mass properties during procurement and use of space vehicles, or portions thereof. It is designed to permit the acquisition of systematized, verifiable, and controllable mass properties of vehicle systems; to facilitate rapid establishment and reporting of inputs for the weight/performance relationship; and to enable parametric extrapolation from the reported systems to newly evolving systems.

NASA SP-6004 1965 88 pp. CFSTI \$3.00

Reliability Program Evaluation Procedures

The objectives of this document are (1) to establish uniform standards for evaluating the degree and effectiveness of reliability practices and controls; (2) to identify reliability problems for evaluation and correction; (3) to permit evaluation of the various methods of controlling a specific area leading to improved reliability and safety levels. These standards may be used to survey contractual compliance to all reliability publications. They are designed to identify problem and improvement areas consistent with the severe reliability and safety requirements of manned space-flight systems.

NASA SP-6002 1963 52 pp. CFSTI \$3.00

Quality Program Evaluation Procedures

Procedures and related survey checklists to be used in evaluating quality procedures and controls being applied to manned space-flight programs. The program has three objectives: (1) to establish uniform standards for evaluating the degree and effectiveness of quality practices and controls; (2) to identify quality problems for evaluation and correction; and (3) to permit evaluation of various methods of controlling a specific quality area, leading to improved reliability and safety levels. The program is designed to identify problem and improvement areas consistent with the severe reliability and safety requirements of manned space-flight systems.

NASA SP-6003 1963 69 pp. CFSTI \$3.00

Bibliographies and Other Reference Works

Lunar Surface Studies: a Continuing Bibliography

A selection of annotated references to reports and journal articles introduced into the NASA information system during the period February 1966-January 1967. Subjects include the theory of origin, atmosphere, and physical characteristics of the Moon. Techniques for lunar observation, measurement, and analysis are also covered. Subject and author indexes.

NASA SP-7003(03) 1966 71 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7003(02), reflecting NASA acquisitions February 1965-January 1966 (36 pp. CFSTI \$3.00); NASA SP-7003(01); April 1964-January 1965 (54 pp. CFSTI \$3.00); and NASA SP-7003, January 1962-March 1964 (98 pp. CFSTI \$3.00).

Communications Satellites: a Continuing Bibliography

Annotated listing or report and journal literature on the subject introduced into the NASA information system during the period February 1966-March 1967. Subject and author indexes.

NASA SP-7004(03) 1967 47 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7004(02) containing references acquired February 1965-January 1966 (39 pp. CFSTI \$1.00); NASA SP-7004(01), May 1964-January 1965 (56 pp. CFSTI \$1.00); and NASA SP-7004, January 1962-April 1964 (90 pp. CFSTI \$1.00).

Aerospace Medicine and Biology: a Continuing Bibliography

Annotated bibliography concentrating on the biological, physiological, psychological, and environmental effects on man during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Among related topics covered are sanitary problems, pharmacology, toxicology, safety and survival, life-support systems, exobiology, and personnel factors. This most recent supplement contains references to NASA acquisitions during May 1967. Subject, corporate source, and author indexes.

NASA SP-7011(37) 1967 78 pp. CFSTI \$1.00

Previous 1967 issues under the same title: SP-7011(36), containing selected references acquired in April 1967 (69 pp. CFSTI \$3.00); SP-7011(35), March 1967 (70 pp. CFSTI \$3.00); SP-7011(34), February 1967 (101 pp. CFSTI \$3.00); and SP-7011(32), January 1967 (81 pp. CFSTI \$3.00).

Previous 1966 issues under the same title: SP-7011(23), containing selected references acquired in March 1966 (68 pp. CFSTI \$1.00); SP-7011(22), February 1966 (80 pp. CFSTI \$1.00); and SP-7011(21), January 1966 (52 pp. CFSTI \$1.00).

Cumulative Indexes are available for previous years: "A Cumulative Index to the 1966 Issues of a Continuing Bibliography on Aerospace Medicine and Biology," NASA SP-7011(33); 556 pp. CFSTI \$3.00; "A Cumulative Index to the 1965 Issues of a Continuing Bibliography on Aerospace Medicine and Biology," NASA SP-7011(20), 721 pp. CFSTI \$3.00; and "A Cumulative Index to the 1964 Issues of a Continuing Bibliography on Aerospace Medicine and Biology," NASA SP-7011(07), 554 pp. CFSTI \$3.00. Supplements may also be purchased individually from CFSTI for \$3.00 per copy.

High Energy Propellants: a Continuing Bibliography

Annotated references to report and journal literature on the subject introduced into the NASA information system January–December 1966. Emphasis is on solid, liquid, and hybrid propellants and oxidizers, but the bibliography also covers such related topics as propellant handling and storage, combustion characteristics, toxicity, and safety measures. Subject and author indexes. NASA SP-7002(03) 1967 68 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7002(02), January–December 1965 (48 pp. CFSTI \$3.00); NASA SP-7002(01), containing references to NASA acquisitions April–December 1964 (98 pp. CFSTI \$3.00); and NASA SP-7002, January 1962–March 1964 (65 pp. CFSTI \$3.00).

Planetary Atmospheres: a Continuing Bibliography

Annotated references to unclassified reports and journal articles introduced into the NASA information system during the period February 1965–May 1966. A large number of these references were produced as a result of the Mariner II and Mariner IV probes of the atmospheres of Venus and Mars. A limited number refer to the atmospheres of Jupiter, Mercury, and Saturn. NASA SP-7017(01) 1966 135 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7017, containing references acquired from January 1962 to February 1965 (144 pp. CFSTI \$3.00).

Lasers and Masers: a Continuing Bibliography

A bibliography of annotated references on the characteristics and applications of lasers and masers that were introduced into the NASA information system between February 1965 and April 1966. NASA SP-7009(01) 1966 465 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7009 containing references acquired between January 1962 and February 1965 (280 pp. CFSTI \$3.00).

Lubrication, Corrosion, and Wear: a Continuing Bibliography

Annotated bibliography of references stored in the NASA information system from April 1965 to August 1966. NASA SP-7020(01) 1966 296 pp. CFSTI \$3.00

Previously issued under the same title: SP-7020, containing references acquired from January 1962 through March 1965 (167 pp. CFSTI \$3.00).

Particles and Fields Research: a Bibliography

An extensive list of references to journal articles, books, conference proceedings, and English translations of foreign journals published between January 1958 and May 1966. Particularly comprehensive with regard to space research on energetic particles and on magnetic and electric fields. NASA SP-7026 1966 173 pp. CFSTI \$3.00

Bibliographies on Aerospace Science: a Continuing Bibliography

Annotated references to unclassified bibliographies in the field of aerospace science introduced into the NASA information system in the period February 1965–April 1966. Subject and author indexes. NASA SP-7006(02) 1966 100 pp. CFSTI \$3.00

Previously issued under the same title: NASA SP-7006(01), containing references acquired June 1964–February 1965 (57 pp. CFSTI \$3.00), and NASA SP-7006, January 1962–May 1964 (52 pp. CFSTI \$3.00).

Extraterrestrial Life: a Bibliography

Part I, Report Literature

Part II, Published Literature

A comprehensive collection of annotated references on the general subjects of extraterrestrial life and exobiology, including such related topics as the origin of life on Earth and terrestrial contamination of spacecraft. Part I consists of references to selected domestic and foreign reports prepared during the period 1962 through July 1964; Part II lists journal articles and books published in the period 1900-1964. A limited selection of 1965 sources is also included. The first volume is indexed by subject, author, corporate source, and contract number. The subject and author indexes of the second volume also cover information contained in Part I.

NASA SP-7015 Part I 1965 80 pp. GPO 45 cents
NASA SP-7015 Part II 1965 345 pp. GPO \$2.00

Space Communications:

Theory and Applications, a Bibliography

Vol. 1: Modulation and Channels

Vol. 2: Coding and Detection Theory

Vol. 3: Information Processing and Advanced Techniques

Vol. 4: Satellite and Deep Space Applications

A four-volume bibliography containing an extensive listing of references to reports, articles, and books on several subjects directly pertinent to the field of space communications. The compilers have endeavored to provide maximum coverage of the literature for the period 1958 through 1963. References to publications of unusual significance that appeared before 1958, as well as a limited number of 1964 sources, have also been included.

Subject index.

NASA SP-7022(01) 1965 Vol. 1 486 pp. GPO \$2.50
NASA SP-7022(02) 1965 Vol. 2 426 pp. GPO \$2.25
NASA SP-7022(03) 1965 Vol. 3 463 pp. GPO \$2.50
NASA SP-7022(04) 1965 Vol. 4 303 pp. GPO \$1.75

Ballistocardiography: a Bibliography

Selected bibliography of reports and journal articles, of both domestic and foreign origin, published during the period 1877-1964. Prepared by staff members of the Federal Aviation Agency and published jointly by FAA and NASA. The document also carries the number FAA AM 65-15.

NASA SP-7021 1965 49 pp. GPO 35 cents

Bibliography Related to Human Factors System Program (July 1962-February 1964)

By Richard J. Potocko

Bibliography divided into 18 categories covering human research and performance, man-systems integration, and life-support and protective systems. Also relevant listings under biology, physiology, and psychology. Each listing includes information for locating an abstract in STAR and IAA.

NASA SP-7014 1964 242 pp. CFSTI \$3.00

The International System of Units— Physical Constants and Conversion Factors

Compiled by E. A. Mechtly

This document defines the basic units of the Systeme International, adopted officially by the 1960 Eleventh General Conference on Weights and Measures, and tables for converting from U.S. customary units.

NASA SP-7012 1965 20 pp. GPO 20 cents

Preparing Contractor Reports for NASA: Data Presentation

A "how-to" booklet, with emphasis placed upon latitude of presentation open to authors of NASA contractor reports. Various types of graphs and tables are discussed and concrete suggestions are given for most effective, economical preparation of such reports.

NASA SP-7025 1966 19 pp. GPO 15 cents

Preparing Contractor Reports for NASA: Repro Typing and Layout

By Proctor P. Taylor, Jr.

Ground rules for the production of suitable reproducible copy with a minimum of effort. Topics discussed are: (1) the typewriter; (2) the reproducible layout sheet; (3) section headings; (4) spacing; (5) hyphenation; (6) error correction; (7) typing tables and figures; (8) the reproducible layout; (9) figuring reductions; and (10) typing equations.

NASA SP-7007 1964 19 pp. GPO 15 cents

Preparing Contractor Reports for NASA: Technical Illustrating

Guidelines to insure the proper selection of size, shape, and style of illustrations for use in printed technical publications for NASA. The following areas are covered in detail: (1) materials; (2) graphs; (3) line drawings; (4) perspective drawings; (5) typography and lettering; (6) photographs; (7) layouts; and (8) figuring reductions.

NASA SP-7008 1964 27 pp. GPO 15 cents

Clarity in Technical Reporting

By S. Katzoff

Common sense suggestions for improving written technical reports. In particular, the booklet discusses basic attitudes, some elements of composition, the organization and contents of the report and the editorial review.

NASA SP-7010 1964 25 pp. GPO 15 cents

A Selected Listing of NASA Scientific and Technical Reports for 1966

Annotated listing of NASA reports and journal articles announced during 1966 in *Scientific and Technical Aerospace Reports (STAR)*. Included are Special Publications, Technical Reports, Technical Notes, Technical Memorandums, Technical Translations, and Contractor Reports.

NASA SP-7028 1967 2080 pp. \$9.75

Similar listings available for 1965, 1964 and 1963: NASA SP-7024 (1400 pp. GPO \$7.00), NASA SP-7018 (1132 pp. GPO \$5.25), and NASA SP-7005 (236 pp. CFSTI \$3.00).

Guide to the Subject Indexes for Scientific and Aerospace Reports

Third revised edition.

NASA SP-7016 1960 71 pp. CFSTI \$3.00

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☆ U.S. Government Printing Office: 1967—O 277-198